

# CARNIVOROUS PLANT NEWSLETTER

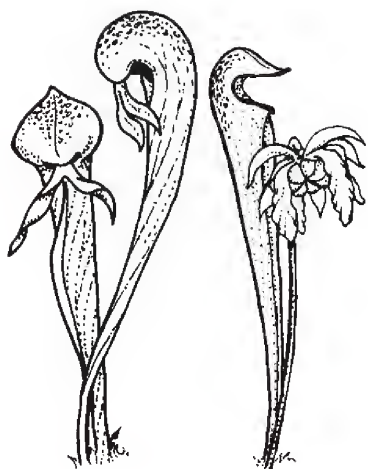
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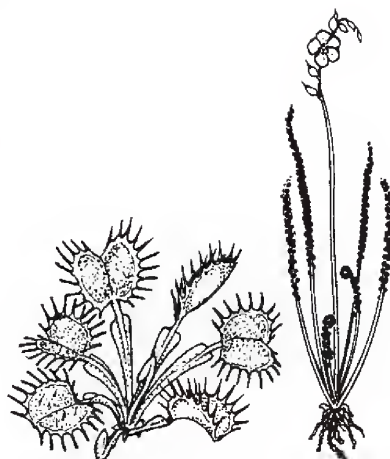




# CARNIVOROUS PLANT NEWSLETTER

Journal of the International  
Carnivorous Plant Society  
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Volume 40, Number 1  
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**Front Cover:** *Drosera tracyi* growing with *Pinguicula planifolia* in temporarily flooded conditions; Apalachicola National Forest (Liberty County, Florida). Photo by Barry Rice. Article on page 4.

**Back Cover:** The striking dark coloration of a dark color variant of the recently discovered *Nepenthes leonardoi*. Note the purple-colored exterior surface of the pitcher is lined with short, brown hairs. Photo by Stewart McPherson. Article on page 28.

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## THE THREAD-LEAF SUNDEWS *DROSERA FILIFORMIS* AND *DROSERA TRACYI*

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### Introduction

The thread-leaf sundews of the Eastern North America are spectacular plants with erect, tall, filiform leaves. Backlit in the morning or evening light, their leaves burst with sunlight. There are two thread-leaf sundews (also known as dew-threads), known as either infraspecific taxa within *Drosera filiformis*, or as *Drosera filiformis* and *Drosera tracyi*. In this paper, I review their history of discovery, the details of their ranges, and the arguments regarding whether the two taxa should be treated as one species or two. I also describe the morphological differences between the two sundews. In total, this paper summarizes the current knowledge for this group, and also serves as a progress report on my continuing work on these plants.

### A history of controversy

In 1808, Rafinesque described the thread-leaf sundew, *Drosera filiformis* Raf., which occurs on the Atlantic Coast of North America. The 1802 holotype he selected for this description is one of the oldest North American herbarium specimens housed in a North American herbarium (Sheviak 2010). In 1906, Diels noted that specimens from the USA's Gulf Coast were larger and greener, so he established for them the name *D. filiformis* var. *tracyi* Diels. In doing so, the name *D. filiformis* Raf. var. *filiformis* was created automatically (*i.e.*, an autonym) for the smaller, reddish thread-leaf sundew.

Diels obtained the varietal epithet “*tracyi*” from J.M. Macfarlane, who felt that the Gulf Coast plant should be treated as a new species (“*D. tracyi*”). While Diels disagreed, he did Macfarlane the courtesy of using his epithet, and even decorously noted “*Macfarlane msc. sub titulo speciei*” in the description for *D. filiformis* var. *tracyi* Diels. Schnell (2002) interpreted this Latin phrase to indicate that Macfarlane had an as-yet unpublished manuscript describing the plant as a new species—or at least intended to write such a manuscript!

Good intentions perhaps, but Macfarlane did not actually publish the name *Drosera tracyi* until his treatment of *Drosera* in Bailey's “The Standard Cyclopedia of Horticulture” (Macfarlane 1914; page 1077). Schnell (2002) argued that this publication did not constitute effective publication of the name “*D. tracyi*” because it was not accompanied by a Latin description. (The only Latin description for the plant was published by Diels, in the treatment for “*Drosera filiformis* var. *tracyi*.” However, Macfarlane did not refer to the Diels description.) However, the Latin description requirement—as described by the ICBN (Article 36.1)—only applies to names described on or after 1 January 1935. Therefore, *D. tracyi* Macf. is entirely valid for those who wish to use it.

Thirty years later, Frances Wynne noted that the sundews in eastern North America have distinct seeds shapes and surface characteristics (Wynne 1944). Since the seeds of the two thread-leaf



sundews were identical, she followed Diels' perspective and treated them as two varieties of the same species. (She also established the name "*D. filiformis* var. *typica*," but this is a superfluous synonym for *D. filiformis* Raf. var. *filiformis* and should not be used.)

In the sixty-five years since Wynne's work, authorities have continued to disagree on whether to treat the thread-leaf sundews as one species or two. Gleason & Cronquist (1991) do not even recognize the two sundews as separate at the varietal level. (Oddly, the geographic distribution they describe for "*D. filiformis*" combines the range for both thread-leaf sundews, but their species description only fits the northern taxon's morphology and size.) Scientists who treat the thread-leaf sundews as varieties of one species include Kartesz (1994), Schnell (2002), and Schlauer (2002). Meanwhile authorities who treat them as two species include Clewell (1985), Godfrey & Wooten (1981), L. Mellichamp (pers. comm., 2010), and Sorrie (1998). Overall, in the last decade the two-species perspective has become dominant in floristic works—examples include The Biota of North America Program (BONAP.org), the Flora of North America (fna.org), The Flora of the Southern and Mid-Atlantic States (Weakley 2010), and NatureServe (NatureServe.org). Within the world of carnivorous plant enthusiasts, the tradition has typically been to follow the single-species perspective<sup>1</sup>.

Molecular studies have been illuminating many aspects of *Drosera* phylogeny (Rivadavia *et al.* 2003), but they have not been applied to the matter of the thread-leaf sundews, and even if they were, would be unlikely to reveal much regarding these two closely related taxa.

My own perspectives of the two sundews have evolved over time. I long used the single-species approach (Rice 2006), but my interest in the Floridian "red" *D. filiformis* has caused me to revisit this carefully and in depth. After much consideration on this matter, I have switched to the two-species perspective. For simplicity, the rest of this paper will be presented using the two-species nomenclature.

#### The ranges of *Drosera tracyi* and *D. filiformis*

*Drosera tracyi* is native to an ever-shrinking range in the USA's Gulf Coast states (Figure 1). Much of its quoted habitat range is now purely of historical interest. Ranges below are based upon collections made or confirmed within the last ten years.

**Florida:** This state contains the bulk of the species' range. *Drosera tracyi* has been collected in every county of the panhandle (*i.e.*, the narrow, western extension of the state), from Wakulla and Leon Counties westward, with the apparent exception of Gadsen County (Sorrie 1998; Wunderlin & Hansen 2008).

**Georgia:** It was formerly known from Brooks, Calhoun, Cook, Grady, Lowndes, Thomas, and Worth Counties, but is apparently now extinct in them all (NatureServe 2008; Sorrie 1998). It is now only known from Colquitt County. Since it is known from only five or fewer occurrences in the state, it is considered critically imperiled by the Georgia Department of Natural Resources.

**Alabama:** It has been collected from Mobile, Baldwin, Washington, Escambia, and Covington Counties (BONAP 2010; Sorrie 1998; USDA 2010).

**Mississippi:** Known from Hancock, Harrison, Jackson, Stone, George, and Perry Counties (BONAP 2010; Sorrie 1998; USDA 2010).

**Louisiana:** A single poorly documented collection was made in 1907, putatively from an unspecified parish in Louisiana; if this information is correct, the plant is probably from St. Tammany or Washington Parish (Sorrie 1998). The Louisiana Natural Heritage Program tracks this species in

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<sup>1</sup>This is no doubt at least partly because of the considerable authority and prominence Schnell has had with this audience. He was editor of Carnivorous Plant Newsletter from its inception to 1996.



Figure 1: A 2010 snapshot of the range of *Drosera tracyi*. Counties or parishes believed to currently maintain native populations are indicated by a black dot. Counties where it is believed *D. tracyi* has been extirpated are indicated by an empty circle. The question mark for the Louisiana site notes that it has not been confirmed that *Drosera tracyi* has ever occurred there.

their databases as a plant from St. Tammany Parish, but considers it to be presumably extinct in the state (LNHP 1999).

**South Carolina:** Reports in the literature for this plant in this state (*e.g.*, Wynne 1944) do not seem to be supported by voucher specimens.

**Other sites:** *Drosera tracyi* has been planted by horticulturists in California (Mendocino County). No doubt exotic plantings occur elsewhere in North America and around the world.

*Drosera filiformis* has a range which is strikingly different from that of *D. tracyi* for two reasons. First, instead of being strictly a USA Gulf Coast plant, it occurs primarily along the Atlantic Coast of North America (Figure 2). Second, instead of being largely continuous, its range is divided into four greatly separated segments: Nova Scotia (Canada), USA mid-Atlantic states, North Carolina, and Florida. The Nova Scotia range segment is only 20 km long. The mid-Atlantic range segment is 450 km southwest of the Nova Scotia sites, and spans more than 600 km of the Atlantic Coast. Approximately 450 km separates the mid-Atlantic range segment from the North Carolina segment, which itself is approximately 140 km in extent (county edge to county edge). Finally, 850 km separates the North Carolina segment from the Florida populations—a cluster of sites only 20 km across.

Unfortunately, the range of *D. filiformis*, like that of *D. tracyi*, is decreasing rapidly in extent and quality.

### **Canada Range Segment**

**Nova Scotia (Canada):** *Drosera filiformis* was discovered in 1977 in Shelburne County (Sorrie 1998); peat studies indicate it has grown there for at least 4240 years (Landry & Cwynar 2005). Because of its great rarity—it is only known from five locations—it has been declared an endangered species by government agencies in both Nova Scotia and Canada (COSEWIC 1991; NSSRWG 2000). In fact, the presence of *D. filiformis* prevented one bog from being turned into a peat mining operation (Landry & Cwynar 2005).

### **USA Mid-Atlantic Range Segment**

**Massachusetts:** It has been found in Plymouth, Barnstable, Nantucket, and Dukes Counties (Sorrie 1998; USDA 2010), although it is extinct at many of its former sites in the state.

**Rhode Island:** A single small population was recorded for Washington County in 1977, but it apparently dwindled to extinction around 1990 (Enser 2007; Sorrie 1998). It has been theorized (Sorrie 1998) that the populations in Rhode Island and Massachusetts might be short-term in nature—as new sites are opened by disturbance, *D. filiformis* propagules from other states may invade until the site becomes overgrown. Sorrie's suggestion of wind dispersal from the nearby (<150 km) New York populations seems less likely than transport by waterfowl from New York or Massachusetts. If this dispersal theory is correct, the natural human tendency to fragment habitat and prevent natural succession processes suggests that *D. filiformis* is unlikely to reestablish itself in Rhode Island and Massachusetts.

**Connecticut:** It has been found in New London and Hartford Counties, but these populations are probably extinct because of habitat change (Sorrie 1998). It is listed in Connecticut as a “probably extirpated” plant of Special Concern by the Connecticut Department of Environmental Protection (ct.gov/dep).

**New York:** It occurs only in Suffolk County on Long Island, and as such it is on the state's Rare Plant List (Sorrie 1998; Young 2010). Fortunately, at least one site is owned and protected by The Nature Conservancy (nature.org).



Figure 2: A 2010 snapshot of the range of *Drosera filiformis*. Counties believed to currently maintain native populations are indicated by a black dot. Counties where it is believed *D. filiformis* has been extirpated are indicated by an empty circle. Only native sites have been plotted. The question marks for the Delaware and Maryland sites note that it has not been confirmed that *Drosera filiformis* has ever occurred as a native at these locations.



**New Jersey:** Records include Monmouth, Ocean, Burlington, Camden, Atlantic, and Cape May Counties.

**Maryland:** It occurs in Charles County, and a non-native population has also been found in Prince Georges County (Shetler & Orli 2000; Sorrie 1998). The non-native planting casts some doubt upon the nativity of the Charles County site, but there is no certainty in this matter.

**Delaware:** Fernald (1931) indicated the presence of *D. filiformis* in Sussex County, but no voucher specimens have been found to support this claim (Sorrie 1998).

### **Carolinas Range Segment**

**North Carolina:** It has been recorded from Bladen, Brunswick, Columbus, Duplin, Pender, Robeson, and Sampson Counties (NatureServe 2008; Sorrie 1998). It is apparently extinct in Brunswick and Pender Counties, and statewide has been reduced to as few as nine populations (Buchanan & Finnegan 2008; Sorrie 1998). Because of its rarity, the North Carolina Natural Heritage Program classifies it as a plant of “special concern,” and recommends this status be elevated to “significantly rare” (Buchanan & Finnegan 2008).

**South Carolina:** Despite frequent reports of *D. filiformis* in South Carolina, no vouchers for the plant from this state have been located, nor is it recorded in regional surveys or Heritage databases (Schnell 2002; Sorrie 1998).

### **Florida Segment**

**Florida:** Known from a cluster of sites in the Florida panhandle, as originally identified by Godfrey (1974). Currently, I know of two sites in Bay County and ten sites in Washington County. These sites are so close that they are easily connected by pollinating insects; no doubt propagules such as seed can be transported from site to site by waterfowl or even flooding. A single collection of a thread-leaf sundew from Liberty County (Apalachicola National Forest) was made in 1987 (Anderson 10436 FSU) with the notation “less robust than *D. tracyi*”. Despite the small stature of this collection, other morphometric criteria indicate this collection is probably *D. tracyi* (Rice, in prep.). I returned to this site in 2010 but was unsuccessful in finding any thread-leaf sundews—woody vegetation had overgrown the area. Even if *D. filiformis* is found in this area, its nativity would be questionable since horticulturists have used various parts of Apalachicola as a dumping ground for non-native carnivorous plants.

**Other sites:** In addition to the questionably non-native population in Maryland, mentioned above, *D. filiformis* has been planted by horticulturists in numerous places, including California (Mendocino County: Rice 2002), Virginia (Caroline County: pers. observation), and West Virginia (Preston County: Breiding 1983; Sorrie 1998). *Drosera filiformis* has been collected in Pennsylvania (Fayette County: Morton & Speedy 2008), but the southern border of Fayette county is only 20 km from the West Virginia site, and so it is likely that the Pennsylvania record simply is another exotic planting. A single non-native planting of *D. ×hybrida* (= *D. filiformis* × *intermedia*) was recorded in California (Plumas County: Rice 2005) but it has probably been successfully eradicated. No doubt exotic plantings of thread-leaf sundews occur elsewhere in North America and around the world.

As seen in Figures 1 and 2, the ranges of the two species are dramatically different. The tiny amount of overlap region in Florida is not significant in light of the other, vastly greater differences. Interestingly, Sorrie (1998) notes that the pairing of two species, one being from the Gulf Coast and the other from the Atlantic Coast, is not unique to the thread-leaf sundews. This sort of pairing is repeated within other genera, *i.e.*, *Sabatia kennedyana* Fern. (Nova Scotia to South Carolina) and *S. foliosa* Fern. (South Carolina to Texas); *Coreopsis rosea* Nutt. (Nova Scotia to Georgia) and *C. nudata* Nutt. (Georgia to Louisiana). To this, we can add *Sarracenia purpurea* L. (Canada to Georgia) and *S. rosea* Naczi, Case & Case (Georgia to Mississippi).



Figure 3: *Drosera filiformis* growing on sandy flats in New Jersey (Ocean County).

### Merge or split the thread-leaf sundews?

Should *Drosera filiformis* and *D. tracyi* be treated as two species, as two varieties, or even with no taxonomic recognition, as described near the beginning of this paper? The main points of discussion are three:

- 1) The two taxa are not particularly different on vegetative or floral characters;
- 2) The seeds of the two taxa are, essentially, identical;
- 3) Hybrids between the two species are possible and recorded in the wild (Rice 2010); furthermore they are fertile.

Can the two taxa easily be separated on gross morphological grounds? Clearly the plants have different pigmentations. As reviewed in Table 1 (from Sorrie 1998), *D. filiformis* is more deeply pigmented (Figure 3; reddish leaves, reddish tentacles, red gland heads) than *D. tracyi* (Figure 4; green leaves, green-white tentacles, red gland heads). But basing species distinctions on minor matters like pigmentation is inadequate. For example, it resulted in the erroneous separation of *D. brevifolia* Pursh into the white flowered “*D. leucantha* Shinnery” and the pink-flowered “*D. annua* Reed” (Schnell 2002).

Further important characters that distinguish the two taxa are given in Table 1. In Tables 2 and 3, I present additional data from my own studies—Table 2 contains characters showing the entire range of values observed, while Table 3 shows the ranges as calculated by one-sigma variations around the group averages<sup>2</sup>. Some of the characters may not seem significantly different between the two

<sup>2</sup>The one-sigma range is a statistical measure; it contains about 68.2% of the values you are likely to encounter in a sample, and is a good way to specify the range of values you are likely to get when you measure a quantity.





Figure 4: A close view of an unfurling leaf of *Drosera tracyi*.



Figure 5: The white-flowering, mutant form of *Drosera tracyi*.

species when you consider the total ranges shown in Table 2—for example the number of flowers per inflorescence can range from 4 to 21 for *D. filiformis* and 12 to 20 for *D. tracyi*. The overlap here is significant, but the one-sigma ranges in Table 3 do differ much more clearly, *i.e.*, 7-15 for *D. filiformis* and 13-19 for *D. tracyi*.

It is interesting that the tentacles of *D. filiformis* are longer than those of *D. tracyi*. The differences are particularly clear when normalized by the leaf width. The tentacle length/leaf width is 2.6-4.8 for *D. filiformis* and 0.9-2.3 for *D. tracyi*. Notice that, in this case, the smaller plant has the largest tentacles.

Similarly, the relative geometry of the leaves, expressed by the ratio of the total leaf length divided by petiole length is different for the two species: 18-110 for *D. filiformis* and 5.1-25 for *D. tracyi*.

Table 1: Characters used to distinguish <i>Drosera filiformis</i> and <i>D. tracyi</i> . <sup>1</sup>		
Character	<i>Drosera filiformis</i>	<i>Drosera tracyi</i>
Leaf length	8-25 (30) cm	30-50 cm
Scape length	6-26 cm	25-60 cm
Petal length	0.7-1 (1.2) cm	1.2-1.7 (2) cm
Color of carnivorous glandular hairs	red to dark red	pale green
Color of living plant when backlit	reddish	white
Color of dried specimen	dark red to dark brown	pale greenish brown
<sup>1</sup> Data from Sorrie (1998).		



Table 2: Characters used to distinguish <i>Drosera filiformis</i> and <i>D. tracyi</i> . <sup>1</sup>		
Character	<i>Drosera filiformis</i>	<i>Drosera tracyi</i>
	total range	total range
Leaf length	6-25 cm	24-34.5 cm
Petiole length <sup>2</sup>	1-16 mm	6-70 mm
Scape length	7.8-25 cm	28-47 cm
# of flowers	4-21	12-20
Tentacle length <sup>3</sup>	0.7-3.2 mm	0.8-2.5 mm
Tentacle/leaf width	1.3-6.7	0.7-3.8
Leaf/petiole	9.9-170	4.5-53
<sup>1</sup> Original data. <sup>2</sup> The petiole is the nonglandular portion of the leaf, near the basal bud. <sup>3</sup> Obtained by measuring the longest tentacles (including gland tip) near leaf midpoint (half-way up the leaf), avoiding tentacles that were obviously damaged or distorted by the preservation process.		

In summary, I believe the data in Tables 1-3 support species recognition because the differences between *D. filiformis* and *D. tracyi* are not restricted to one or two characters. At least four independent characters are different: size of vegetative parts (leaves), size of flowers, leaf coloration, and the relative dimensions as expressed by tentacle/leaf and leaf/petiole ratios.

Ironically, the fact that the thread-leaf sundews are so different from other *Drosera* contributes to their being interpreted as a single species. The only other species in the genus even remotely similar in form is the South American *D. graminifolia* St. Hil. As a result, the differences between *D. filiformis* and *D. tracyi* seem less significant, when in fact they are considerable.

The second argument about the thread-leaf sundews is the observation that, in North America, all the *Drosera* species have seeds that are uniquely identifiable under a microscope (Wynne 1944). Shape and surface ornamentation allow for easy identification of every North America species. However, the thread-leaf species cannot be distinguished from each other on the basis of seed characteristics.

Table 3: Characters used to distinguish <i>Drosera filiformis</i> and <i>D. tracyi</i> . <sup>1</sup>		
Character	<i>Drosera filiformis</i>	<i>Drosera tracyi</i>
	(ave-1σ)—(ave+1σ)	(ave-1σ)—(ave+1σ)
Leaf length	9.7-17 cm	26-32 cm
Petiole length <sup>2</sup>	0-9 mm	11-44 mm
Scape length	8.9-19 cm	31-45 cm
# of flowers	7-15	13-19
Tentacle length <sup>3</sup>	1.3-2.4 mm	1.0-1.8
Tentacle/leaf width	2.6-4.8	0.9-2.3
Leaf/petiole	18-110	5.1-25
<sup>1</sup> Original data. <sup>2</sup> The petiole is the nonglandular portion of the leaf, near the basal bud. <sup>3</sup> Obtained by measuring the longest typical tentacles (including gland tip) near leaf midpoint (half-way up the leaf), avoiding tentacles that were obviously damaged or distorted by the preservation process.		

This fact is undeniable, but is it significant? Elsewhere in the genus, seed coat is used only rarely to key species (Diels 1906; Lowrie 1987, 1989; Schlauer 1996). Perhaps one might devise a key based solely upon seed characteristics, but this is purely speculative. I argue that while it is undeniable that seed coats are distinct for most of the various species present in North America, it simply does not work for them all. In the same way, stipule characteristics can be used to identify many of the North American *Drosera*, but not all of them. Indeed, it is a very rare case that one encounters a botanical key that relies exclusively on one character. The fact that seed coats are different for many species of *Drosera* in North America is a useful and convenient tool in identification, but there is little evidence that it is a strong diagnostic for species variation across the genus, or even within section *Drosera*.

The final argument that these species should be lumped is based upon the observation that the two species can be hybridized, and the resulting progeny are fertile (Robinson 1981). Fertile hybrids between *D. filiformis* and *D. tracyi* have even been observed at a single site in the wild (Rice 2010). This is a powerful observation, and must be addressed completely.

As is commonly taught in school, interspecies infertility is a robust method of identifying separate species of vertebrate animals. But this metric is not as reliable in the plant world. Carnivorous plant enthusiasts are familiar with the fact that wild and cultivated fertile hybrids are common in *Heliamphora*, *Nepenthes*, and *Sarracenia* (Clarke; McPherson 2007; Rice 2006). Elsewhere in the wild and in horticulture, fertile hybrids are common in grapes, oaks, roses, tamarisk, violets, and countless other plant groups (Mabberley 1997). In some cases it is even possible to cross plants of different genera, resulting in fertile hybrid genera such as  $\times$ *Triticosecale* ( $=$ *Triticum*  $\times$  *Secale*),  $\times$ *Fatschедера* ( $=$ *Fatsia*  $\times$  *Hedera*), or even bizarre multigenera orchid hybrids such as  $\times$ *Brilliandeara* ( $=$  *Aspasia*  $\times$  *Brassia*  $\times$  *Cochlioda*  $\times$  *Miltonia*  $\times$  *Odontoglossum*  $\times$  *Oncidium*).

Interspecific hybrids are frequent within *Drosera*. In horticulture, enthusiasts have produced the fertile hybrids *D. anglica*  $\times$  *nagamotoi*, *D. burmannii*  $\times$  *sessilifolia*, and *D. dielsiana*  $\times$  *nidiformis* (Snyder 2000), and many others.

*Drosera* hybrids also occur in the wild. All the species in section *Lasiocephala* (i.e., the “*petiolaris* complex”) hybridize in the wild and in cultivation (Lowrie 1999). Additionally, natural populations of *D.  $\times$ sidjamesii* ( $=$ *D. omissa*  $\times$  *pulchella*) have developed fertile, seed-setting plants (Lowrie & Conran 2007). Within section *Drosera*, hybrids are frequent; not only are they fertile in the case of the thread-leaf sundews, but fertile first-generation crosses have been observed involving Zambian species (Rivadavia, pers. comm., 2010). Natural hybrids such as *D. rotundifolia*  $\times$  *linearis* and *D. rotundifolia*  $\times$  *spatulata* are sterile in their first generation, but can apparently become fertile in subsequent populations *via* natural chromosome doubling, thus establishing *D. anglica* and *D. tokaiensis*, respectively (Schlauer 2010; Seno 2003).

Does interfertility mean the two thread-leaf sundews are the same species? I do not think so, but I believe that it indicates that the speciation (separation of the two species) is probably recent—Sorrie (1998) speculates that ancestral propagules of *D. filiformis* migrated northwards out of Florida after the Pleistocene (e.g., approximately 12,000 years before present). It is currently a matter of pure speculation as to whether one species evolved from an ancient population of the other, or they both speciated from a common ancestor, or some other scenario.

There are many philosophies on what defines a species. I follow the traditional biological species concept, which is that “species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups” (Mayr 1942). In the case of the thread-leaf sundews, we have two significantly morphologically different populations of plants, which occupy different ranges (and different habitat types within those ranges), and which are—for the most part—not exchanging genetic material. They are, simply, two different species. Those with



Figure 6: A familiar view of *Drosera tracyi*, backlit in the evening sunset (Liberty County, Florida).

different species concepts may come to different conclusions, and I do not fool myself into thinking I have had the last word on the subject of the two thread-leaf sundews. As Peter Taylor (1989) wrote, “Nothing is perfect, except perhaps the plants that we study and attempt to understand....”

#### Varieties, subspecies, or forms of thread-leaf sundews?

There are no infraspecific taxa identified for *D. tracyi*—the species is uniform in characteristics over its entire range. The only known variant is an anthocyanin-free specimen (see Figure 5) collected in Franklin County, Florida (Hummer 1998); this plant’s novel mutation is expressed by its having white flowers and carnivorous gland-heads that are green instead of red. A name for this plant might be established at the rank of “*forma*,” much like the analogous case with *Sarracenia rosea* f. *luteola*. However, current thought in botany is that names are best given to populations of plants that are evolutionary units: species, subspecies, and varieties. The “*forma*” rank is no longer considered of particular value. On the other hand, since such minor differences are appreciated by horticulturists, they can be named as cultivars, much like the green-flowered *Darlingtonia californica* has been named *Darlingtonia* ‘Othello.’

*Drosera filiformis* is a distinctly different beast, however, since its range is fragmented into four separate populations, each of which may have developed different characteristics. In particular, carnivorous plant enthusiasts would very much like to hear of a new designation for the Floridian populations. I have been investigating this matter for several years, but a pronouncement along such lines would currently be premature and scientifically sloppy. I hope to settle this matter to my own satisfaction as soon as possible, but careful research efforts (herbarium loans, morphometric measurements, analyses, etc.) take time to conduct. Until the time that I feel comfortable publishing my



results, I recommend that horticulturists carefully maintain location information for their beloved plants, and strive to be patient!

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## MURDEROUS PLANTS

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The year 2009 was the 150<sup>th</sup> anniversary of Charles Darwin's publication of *On the Origin of Species* (Darwin 1859). It was marked by many celebratory articles including a paper by Mark Chase, Maarten Christenhusz, Dawn Sanders, and Michael Fay published in *Botanical Journal of the Linnean Society* called "Murderous plants: Victorian Gothic, Darwin and modern insights into vegetable carnivory" (Chase *et al.* 2009). In line with the catchy title, the article was a very broad review of carnivorous plants, real and imaginary, along with many plants that the authors considered incomplete carnivores. The article was not a proposal that we call all these plants murderous plants. What the article did though was argue that there is a clear continuum between carnivorous and non-carnivorous plants. That is, one can make up definitions of what is and what is not a carnivorous plant, but in the end any definition is totally arbitrary. I disagree. Carnivorous plants are unique. I think there is an obvious place to draw the line between carnivores and non-carnivores. Any waffling is due to our lack of understanding the plants. However, the Chase *et al.* (2009) article ends with "We may be surrounded by many more murderous plants than we think." This is true; there are more murderous plants than we think.

The idea of "murderous" plants is not new. In his 1875 book *Insectivorous Plants*, Charles Darwin reported on studies he performed on *Saxifraga umbrosa*, *Saxifraga rotundifolia*, *Primula sinensis*, *Pelargonium zonale*, *Erica tetralix*, *Mirabilis longiflora*, and *Nicotiana tabacum* (Darwin 1875). These are all sticky-leaved plants. Darwin did tests on them as he did on his carnivorous plants: he dipped their leaves in raw meat infusions, put solutions of ammonia salts on them, and carefully observed the results. Darwin said "The most interesting case for us is that of the two species of *Saxifraga*, as this genus is distantly allied to *Drosera*. [*Saxifraga* actually is not related to *Drosera*.] Their glands absorb matter from an infusion of raw meat, from solutions of the nitrate and carbonate of ammonia, and apparently from decayed insects. This was shown by the changed dull purple colour of the protoplasm within the cells of the glands, by its state of aggregation, and apparently by its more rapid spontaneous movements." And Darwin concludes his discussion of all seven species with "It is moreover probable that the glands of some of the above named plants obtain animal matter from the insects which are occasionally entangled by the viscid secretion." That is it. That is the total extent of his conclusion. So although Darwin observed dead insects on these plants and determined the plants might actually be able to absorb nutrients from the corpses, at no point does he accuse these plants of being incomplete carnivores or anything related to carnivores. He instead uses them as examples to show that physiologically, carnivorous plants are simply doing certain things other plants do, only better. It is too bad Darwin was not into Victorian Gothic and focus on the killing part. Had he done so and called these non-carnivores "murderous plants", it would have saved a lot of confusion later.

Chase *et al.* (2009) summarized research on more species that have been assessed for potential carnivory. They discussed the sticky plants *Potentilla glandulosa*, *Geranium viscosissimum*, *Petunia violacea*, *Petunia nyctaginiflora*, and *Solanum tuberosum*, plants that use glandular hairs to protect their flowers including *Stylidium* species, *Passiflora foetida*, *Plumbago auriculata*, plants that make pitchers with their leaves including *Dipsacus fullonum*, plants that kill birds including *Puya raimondii* and *Pisonia grandis*, and more. Referring to these and "complete carnivorous plants" they



concluded “We think that it is evident from the descriptions above that many plant species have the capacity to trap and kill insects and other animals and that some have refined the carnivorous syndrome to a high degree. Intermediates (the so-called ‘proto-carnivorous’ species) clearly do exist, and it is tempting to consider many of these to be good carnivores. [...] If carnivory is far more common than previously held because of many species being subtly carnivorous, then the background comparisons of ‘carnivore vs. non-carnivore’ are also inappropriate because the latter category includes perhaps many species that are subtly carnivorous through symbioses with other organisms.” In other words, Chase *et al.* (2009) defined carnivory among plants so broadly that the concept is meaningless. Any plant could be subtly a carnivore. Is this really necessary? I think not.

All plants are or are potentially killers. All plants pack their tissues with toxic substances to stop predation. Plant predators tend to recognize what they can and cannot safely eat so we rarely see corpses on or around most plants. Plants do not just target predators; they target plant competitors as well *via* what we call allelopathy. Plants will do what they can do to survive and reproduce; this includes killing. Carnivorous plants are unique among plants in that they kill for nutrition and they do it in a direct way: kill, digest, absorb, grow, and reproduce. The non-carnivorous plants are not killing for nutrition. They are killing in a body-present-way any potential predator that blunders into them rather than deterring the predator. Other plants are a little aggressive in their methods of pollination or seed dispersal to the point of killing the messenger: you see piles of dead flies or dead birds. These plants are not carnivorous! And they are not proto-carnivorous, semi-carnivorous, para-carnivorous, sub-carnivorous, or incomplete carnivorous either! These plants are simply murderous.

Calling plants that kill in a body-present-way for purposes other than nutrition “murderous plants” is perhaps a little too cute for serious scientists. It does stretch the dictionary definition of “murder” a bit. But we need some word so we can do away with all these wanabe-carnivorous terms. Carnivory in plants is not some higher plane of existence. The carnivores we know and love are simply crippled plants that need to kill for necessary nutrition. Murderous plants are not on the road to carnivory, they are not just short of some ideal; they are simply murderous plants and I think we should call them that.

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Editor’s Note: John has recently added a new section to the ICPS public web site, [www.carnivorousplants.org](http://www.carnivorousplants.org), called About Carnivorous Plants. The new section describes what makes carnivorous plants different from non-carnivores and summarizes what is known about their ecology and evolution. It includes a page on each CP genus with links to more information on ICPS web sites including CPN articles. Additional pages on special topics will be added as they are completed.

## WHAT EXACTLY IS A CARNIVOROUS PLANT?

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We all find carnivorous plants fascinating, beautiful, and interesting. But just what is a carnivorous plant? What are the attributes that transform a mundane vegetable into a hungry killer? For a long time I preached that a plant is carnivorous if it attracts, captures, digests, and absorbs prey. This four-point definition seemed to work.

In 2009 I was asked to write a scientific review of carnivorous plants for a technical volume (Rice 2010). I used this opportunity to review prior definitions of carnivory in plants. The first carefully stated definition I could find had two parts: (1) a plant must have at least one adaptation for attraction, capture, or digestion of prey, and (2) that the plant must be able to absorb the nutrients from the prey (Givnish *et al.* 1984). Juniper *et al.* (1989) also offered a definition with two criteria—the possession of both traps and digestive organs. To the common four-point definition (attract, capture, digest, and absorb), Schnell (2002) added that a carnivorous plant must clearly benefit from the obtained nutrients.

Why is it so difficult to easily define what we mean by carnivorous plants? The problem is rooted in two underlying issues: paracarnivory, and hunting inefficiency.

### Paracarnivorous Plants

Paracarnivorous plants are those that have some, but not all, of the characteristics of a carnivorous plant. The situation is exemplified by the two species in the genus *Roridula* (Anderson 2005; Anderson & Midgley 2002). These plants have sticky, prey-capturing leaves. *Roridula* species live in nutrient-poor habitats with *Drosera* and *Utricularia*, so clearly being carnivorous would give them access to valuable resources. However, the sticky fluids on their leaves are resin-based (not mucus-based), and as such cannot transmit digestive fluids from the plant to the prey, nor can they transmit nutrients from the prey back to the plant. Accordingly, *Roridula* was classified noncarnivorous by Lloyd (1942) and many subsequent authors (Schlauer 2002; and others).

Is this classification appropriate? Many studies have shown that creatures captured by the leaves of *Roridula* are consumed by capsid insects that live on the plant, and that feces from these insects are absorbed by the plant through specialized gaps in their waxy cuticle (Anderson 2005). With this in mind, should *Roridula* be considered carnivorous? I believe the answer is clearly “yes”.

A common objection to a carnivorous classification for *Roridula* is based in the fact the plants do not produce their own digestive enzymes. But is this objection valid? Many animals have microbes in their digestive tracts, which facilitate in digestion. Termites provide a famous example of this. Although termites eat wood, they cannot digest it. The enzymes that digest their meals are produced by protozoa and bacteria that live in the termites' digestive tracts. Just as I consider termites to be organisms that eat and digest wood (albeit in a mutual relationship with microbial life), I consider *Roridula* to be a carnivorous plant.

Although the species of *Roridula* are carnivorous because of their symbiotic relationships with insect allies, the mere occurrence of capsid insects on a plant does not mean it is carnivorous. Yes, capsids are frequently found on *Drosera* and *Byblis* in Australia (Hartmeyer 1996; Lowrie 1998).

However, I have also observed them on many other plants, including *Brugmansia*, *Helianthus*, *Ibicella*, and *Stylidium* (Rice 2008; pers. observation). These plants may simply be suitable hunting grounds for the carnivorous capsids, and may not partake in the meals.

Another interesting parallel can be drawn between *Roridula* and *Darlingtonia* (the pitcher plant of western North America). While *Darlingtonia* has evolved a variety of exquisite characters to encourage the capture of prey, the plants in this genus do not produce digestive enzymes. Instead, *Darlingtonia* plants rely upon a suite of commensals such as the ravenous larvae of *Metriocnemus edwardsii* midges (Rice 2006). I look at *Darlingtonia* and I see a carnivorous plant. But really, the only difference between *Darlingtonia* and *Roridula* is one of topology—in *Darlingtonia*, the enzyme producing commensals live internally in pitcher fluids, while in *Roridula* the enzyme producing commensals live on the surface of the plant. This is not the kind of difference that would separate carnivorous from non-carnivorous plants.

Considering the issue of digestive enzymes further, it is useful to look at other intermediate cases in the realm of pitcher plant genera. There is no doubt that many (*Cephalotus*, *Nepenthes*, *Sarracenia*, etc.) produce digestive enzymes. However, even in these cases some of the digestion is performed by commensal organisms ranging in size and complexity from bacteria, to arthropods, and even vertebrate associates (Bradshaw & Holzapfel 2001; Clarke 1997, 2001; Gibson 1999, 2001; Rice 2006; Schnell 2002). As noted, *Darlingtonia* does not produce digestive enzymes, nor do any of the *Heliamphora* except possibly *H. tatei* (Jaffé *et al.* 1992). Meanwhile, the pitchers of *Sarracenia purpurea*—which are unique in the genus for persisting for approximately two years—produce digestive enzymes for only a tiny fraction of their lives (Gallie & Chang 1997).

All this being said, it is important to draw the line between those plants that are only occasionally and incidentally involved in the death and decay of animal life, and those that are truly carnivorous. Adopting an overly-generous definition—such as including all plants that absorb decaying animal products through their roots—would result in the classification of nearly all plants as carnivorous. Chase *et al.* (2009) use this definition, noting that “nearly all plants are capable of a degree of carnivory.” This approach errs in being excessively lax, just as requiring a plant to produce its own digestive enzymes for inclusion in the ranks of carnivory is excessively strict.

### Hunting Inefficiencies

Another reason it is difficult to define plant carnivory is that even the most indisputably ravenous of carnivorous plants are very poor hunters! Who among us hasn’t spent many long minutes watching insects crawling about on the surface of a *Dionaea* plant, only to see it eventually leave without ever having touched a trigger hair? Who hasn’t watched flies, wasps, or ants feed endlessly on the nectar under the lid of a *Sarracenia* or *Nepenthes* plant, before flying safely away? The fact is that most of the creatures that visit carnivorous plants leave safely enough, perhaps even the better for having supped on delicious nectar.

The main reason this issue is important, is that it attacks one of the very pillars of carnivorous plant definitions—do carnivorous plants really attract prey? Clearly, plants such as *Sarracenia*, *Heliamphora*, and *Darlingtonia*, which have nectar-producing glands at key locations on their traps, are quite adept at luring prey to the trap openings. But for the most part, the “attractive properties” of carnivorous plants are taken as a matter of faith—it has been demonstrated for only a small fraction of the so-called carnivorous plants.

For example, *Drosera* and *Pinguicula* are undisputably classified as carnivorous. Yet the only studies comparing the attracting effects of *Drosera* and *Pinguicula* to comparably sized inert traps



(Antor & García 1994; Harms 1999; Watson *et al.* 1982; Zamora 1990, 1995) failed to show any significant active luring by such plants (Ellison & Gotelli 2009)! Many of the carnivorous plants might not lure prey at all—and if we exclude these from the ranks of carnivory, our definition might eliminate many carnivorous plants; at risk are *Drosera*, *Pinguicula*, *Utricularia*, *Genlisea*, *Byblis*, as well as others.

That even the most active of carnivorous plants are poor hunters means that it is difficult to separate the poor but hungry hunters, from the plants that do not seek animal flesh at all!

### A New Definition for Plant Carnivory

So how does one define “carnivorous plants?” One approach is to create a definition and then examine the plant kingdom, asking which satisfy your definition. Another approach is to examine

Table 1. Carnivorous families, genera, and species counts. Note that carnivory in the plant world has evolved separately at least five times. Some of these groups, which contain carnivores of distinctly different strategies, probably represent additional cases where carnivory has developed independently (Ellison & Gotelli 2009, and sources therein).		
<b>Group 1: Caryophyllales</b>		
Dioncophyllaceae	<i>Triphyophyllum</i>	1
Droseraceae	<i>Aldrovanda</i>	1
	<i>Dionaea</i>	1
	<i>Drosera</i>	187
Drosophyllaceae	<i>Drosophyllum</i>	1
Nepenthaceae	<i>Nepenthes</i>	128
<b>Group 2: Ericales</b>		
Roridulaceae	<i>Roridula</i>	2
Sarraceniaceae	<i>Darlingtonia</i>	1
	<i>Heliamphora</i>	18
	<i>Sarracenia</i>	11
<b>Group 3: Lamiales</b>		
Byblidaceae	<i>Byblis</i>	7
Lentibulariaceae	<i>Genlisea</i>	21
	<i>Pinguicula</i>	96
	<i>Utricularia</i>	225
<b>Group 4: Oxalidales</b>		
Cephalotaceae	<i>Cephalotus</i>	1
<b>Group 5: Poales</b>		
Bromeliaceae	<i>Brocchinia</i>	2
	<i>Catopsis</i>	1

the world of plants, observe the syndrome of carnivory, and then craft a definition that includes the plants that seem to fit the role. Following the latter philosophy, I proposed (Rice 2010) the following definition, which seems quite sensible:

1) Clear adaptations to capture prey are present. Such adaptations may include specialized structures (*i.e.*, basic traps such as glandular tentacles or pitcher trap) and/or enhancements to improve the luring and capture of prey (*i.e.*, extrafloral nectaries, attractive UV or pigmentation patterns, odors, hairs that guide prey, *etc.*).

2) A mechanism is present by which prey are degraded into a form that can be assimilated by the plant. The digestive mechanism may be enzymes produced by the plant, decomposition by bacterial activity, or other organisms in a mutualist relationship with the plant (*i.e.*, arthropods as in the cases of *Darlingtonia* and *Roridula*).

3) A pathway is available that allows nutrients to be absorbed into the plant, thus contributing to the plant's competitive and reproductive fitness.

Simply stated, the definition is that a plant must have traps, a digestion mechanism, and a nutrient pathway that benefits the plant.

Using this definition, the families, genera, and species counts for each of the seventeen genera of carnivorous plants of the world are given in Table 1. The picky reader may wish to refer to my web site (Rice 2007), where I maintain more updated species lists than the one above, which is frozen in time.

Plants currently excluded from my list, either because they do not fit my definitions or as yet have inadequate evidence supporting their possible carnivory, include *Aracamunia*, *Capsella*, *Colura*, *Dipsacus*, *Ibicella*, *Paepalanthus*, *Passiflora*, *Philcoxia*, *Proboscidea*, and *Stylidium*. Time may add these to my list.

Does the above definition and resulting species list make sense to you? If not, spend time generating your own definition of "carnivorous plants." It is a pleasant diversion, an interesting exercise, and surprisingly challenging!

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## NEW CULTIVARS

Keywords: cultivar: *Drosera* 'Ambrosia', *Drosera* 'Dreamsicle', *Drosera* 'Woolly Beast', *Drosera* 'Woolly Red'

### *Drosera* 'Ambrosia' and 'Dreamsicle'

Submitted: 13 September 2010

In 2007, I received four plants from Barry Rice labeled as *Drosera tracyi* "white flower" and grew them for almost two years in full Florida sun. I was pleased to find that the plants showed no signs of color whatsoever including the glands, flowers, and tentacles which proved them to be completely anthocyanin free. The plants also produced true from seed. Realizing the vast hybrid potential of the plant, I decided to cross them with one of several Florida all-red forms of *D. filiformis* var. *filiformis* plants that I had existing in my collection from seed harvested during a prior scientific research expedition. Upon germination, the seedlings immediately expressed hybrid vigor with many of the plants taking on the larger, more robust size and paler yellowish leaf color of the anthocyanin-free *D. filiformis* var. *tracyi* parent. Traits of both parents were clearly seen throughout the resulting seedling colony in varying degrees. I selected two plants that clearly showed the traits of both parents (see Figure 1).



Figure 1: For comparison (from left to right) Florida all-red form of *Drosera filiformis* var. *filiformis*, *D.* 'Dreamsicle', *D.* 'Ambrosia', and anthocyanin-free form of *D. filiformis* var. *tracyi*. Photo by Brian Barnes.



Figure 2: The green leaves and red glands of *Drosera* 'Ambrosia'.



Figure 3: The fiery glow of *Drosera* 'Dreamsicle'.

*Drosera* 'Ambrosia' = (anthocyanin-free *D. filiformis* var. *tracyi* × Florida all-red form of *D. filiformis* var. *filiformis*) retains many traits of the anthocyanin-free *D. filiformis* var. *tracyi* parent including pale yellow leaves and colorless tentacles, but has the dark red glands of the Florida all-red form of *D. filiformis* var. *filiformis* (See Figure 2). This tends to make the plant appear similar to *Drosophyllum* in many ways. This varies greatly from the description of *D. 'California Sunset'*, in which the tentacles and glands are "light red to deep pink in color".

*Drosera* 'Dreamsicle' = (Florida all-red form of *D. filiformis* var. *filiformis* × anthocyanin-free *D. filiformis* var. *tracyi*) exhibits the pale-yellowish leaf color of the anthocyanin-free *D. filiformis* var. *tracyi* parent combined with the coloration of the other *D. filiformis* var. *filiformis* parent. However, the leaves, tentacles and glands take on a fiery-orange coloration, giving the overall plant an eerie orange glow (see Figure 3). Once again, this varies greatly from the "light red to deep pink in color" description of the glands and tentacle coloration of *D. 'California Sunset'*. Both forms exhibit very large showy flowers much like *D. filiformis* var. *tracyi* and are infused with the lightest shade of pink (see Figure 4), which I attribute to the white-flowered anthocyanin-free *D. filiformis* var. *tracyi* parent.

A naturally occurring hybrid between the Florida all-red form of *D. filiformis* var. *filiformis* × *D. filiformis* var. *tracyi* exists in the wild in north Florida and was documented by Prof. Barry Rice and myself in 2009 and shows traits relevant to these man-made hybrid crosses.

*D. 'Dreamsicle'* was named after the fiery-orange tentacles and glands that stand out



Figure 4: The large pink showy flowers of the cultivars.



strongly against the pale yellowish leaves which reminded me of a glowing orange popsicle or “creamsicle” as it is called. *D. ‘Ambrosia’* was named after the sweet nectar drink of the gods in Greek mythology. The dark red nectar laden glands of the plant reminded me of such a divine drink! To maintain the desired character traits of these cultivars, vegetative propagation by leaf cuttings and division only.

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The *Drosera* Brian Barnes Group

Submitted: 13 September 2010

In early 2007, I received a *Drosera kenneallyi* and *D. lanata* plant which were both purchased as adult plants from Hert’s Gardens, a respected nursery in Lakeland, Florida. Both plants flowered at the same time later that year at which time I successfully made the hybrid cross: *D. kenneallyi* × *D. lanata*. All of the resulting seedlings immediately showed hybrid vigor, along with the combined traits of the parents in various degrees of intensity. A greener hirsute form that favored the green *D. lanata* parent (*D. ‘Woolly Beast’*) and an all-red hirsute form which greatly favored the *D. kenneal-*



Figure 5: Parents and hybrid flowers for comparison (left to right): *Drosera kenneallyi*, *D. lanata*, and *D. ‘Woolly Beast’*.



Figure 6: Note the hirsute petioles and widened laminae of *Drosera ‘Woolly Beast’* (left) and the blood-red coloration and hirsute characteristics of *D. ‘Woolly Red’* (right).



lyi parent, (*D. 'Woolly Red'*) was chosen from the vast number of resulting hybrid seedlings (see Figures 5 and 6). All resulting hybrid plants also experience dormancy, much like the two parents. However, dormancy can be avoided if proper year-round growing conditions are met in cultivation.

Since both hybrid cultivars and their siblings possess the wide petioles and laminae of *D. kenneallyi* along with the hirsute characteristics of *D. lanata* in varying degrees, the name *Drosera* Brian Barnes Group is therefore applied to all *D. petiolaris*-complex plants that exhibit this very unusual combination of very distinctive unquestionable hybrid traits. The atypical varying hirsute *D. lanata* characteristics of the hybrids are exhibited at various times during the year, however the wide *D. kenneallyi* leaf blade characteristics that are not atypical to *D. lanata* are consistent year-round in both *D. 'Woolly Beast'* and *D. 'Woolly Red'* and other resulting *D. kenneallyi* × *lanata* hybrids in the *Drosera* Brian Barnes Group.

The *Drosera* Brian Barnes Group was named after the author of this publication, who created the above mentioned hybrid cultivars and their siblings. The names *D. 'Woolly Beast'* and *D. 'Woolly Red'* were concluded by combining visible attributes of the plants involved in the hybrid parentage of the two cultivars and their resulting offspring, whose parents are *Drosera kenneallyi* and *Drosera lanata*. To maintain the desired character traits of these cultivars, vegetative propagation by leaf cuttings and division only.

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# AN EXPEDITION TO PALAWAN, PHILIPPINES, AND ANOTHER NEW *NEPENTHES* SPECIES: *NEPENTHES LEONARDOI*

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Keywords: *Nepenthes leonardoi*, Schom-carp Peak, Palawan, Philippines.

In November 2010, I returned to the Philippines to undertake my fifth expedition to the island of Palawan in search of *Nepenthes*. Much had changed since my first trip in 2007. At that time, just two palawean *Nepenthes* were generally recognized – the lowland *N. philippinensis* and the highland *N. mira*. The mysterious *Nepenthes deaniana* had been discovered and named a century earlier, but it had never been rediscovered in the wild, and even the locality where it had originally been found was not known for it did not appear on any maps, neither modern nor old. Since all herbarium specimens of *N. deaniana* had been lost when the Manila herbarium burned at the end of World War II, it remained uncertain whether *N. deaniana* was in fact, distinct from *N. mira* or whether the two plants were the same.

During 2007, I spent three weeks in Palawan with Alastair Robinson and Volker Heinrich. After several unsuccessful efforts, we rediscovered *N. deaniana* together, after deducing that the plant had originally been discovered on Thumbs Peak, a mountain near the capital of the island, Puerto Princesa (McPherson 2009). We also climbed to the unexplored summit of Mount Victoria to discover a new giant *Nepenthes* species which we named *N. attenboroughii*, and we explored Palawan's highest peak to find a further unnamed *Nepenthes* plant, which was later named *N. mantalingajanensis* by Andreas Wistuba and Joachin Nerz who had encountered that plant several years earlier. More recent expeditions revealed two more new *Nepenthes* species; *N. gantungensis* on Mount Gantung, and *N. palawanensis* on Sultan's Peak.

The recent discovery of so many new *Nepenthes* on Palawan, and also on neighboring islands has demonstrated that the diversity of the genus across the Philippines is considerably greater than had previously been assumed. Ever since my first visit to Palawan four years ago, I always wondered why the island had not attracted interest earlier from botanists and, in particular, from *Nepenthes* enthusiasts. Palawan lies seductively close to the isle of Borneo – the great epicenter of the diversity of the genus. The short distance from Borneo, and the similar habitats which it offers, makes Palawan a logical candidate for *Nepenthes* colonization and diversification. Most of Borneo's *Nepenthes* species are highland taxa, and similar to that island, Palawan abounds in peaks and uplands, and also offers considerable geological diversity – including many ultramafic mountains that on Borneo commonly harbor endemic *Nepenthes*.

Palawan's geography also makes it very interesting. It is a long, narrow island that lies obliquely north of Borneo – at only 40 km at its widest point, most of its mountains are quite accessible and relatively easy and fast to climb, indeed none are above 2085 m. Despite the low height of Palawan's peaks, their exposure to the oceanic trade winds and seasonal rainfall cause their natural altitudinal vegetation zonation to be greatly compressed, to the extent that the summits of most of Palawan's mountains harbor a (strikingly narrow) strip of mossy highland plant life (including *Nepenthes*), which on Borneo and Sumatra would be expected to occur at much higher altitudes.

Yet throughout the 20<sup>th</sup> century, Palawan's alluring highlands remained seldom visited and very little explored. The lack of visitors was in part due to violent Islamic separatist movements which had long festered in the south of the island. Although the violence recently cooled, and has now

largely ended, and the island is starting to attract significant numbers of tourists, it is no exaggeration to state that still today the summits of many mountains on Palawan remain completely unvisited and unstudied in terms of the flora and fauna which they hold – particularly peaks and ridge tops that surround large massifs that have only recently been summited.

For all of these reasons, I have always found Palawan to be especially alluring. The friendly palawño people, the wonderful cuisine and interesting indigenous cultures also added to its appeal. And so, last November I set out once again, this time in the company of two friends and *Nepenthes* experts, Greg Bourke, and Mark Jaunzems, and a Filipino friend and climbing enthusiast Jehson Cervancia. Our goal was to return to the Victoria Massif – a complex of mountains home to *N. attenboroughii* and *N. palawanensis*. In the north of the Victoria Massif, there lies a very interesting U-shaped mountain system that is demarcated by high ridgetops that tightly enclose a river and drainage system on the northern, eastern, and southern sides. This U-shaped mountain complex does not appear to have been explored previously. I found no records of any earlier expedition prior to the trip, and still do not know of any. Indeed, it does not even have a formal name – it does not appear on most maps and charts, and where it is depicted, it is usually known incorrectly under the name “Brow Shoulder”, a title that actually refers to a high and conspicuous separate peak further to the west.

On previous expeditions, I had noted this nameless U-shaped complex as an area to be of great interest for future exploration for *Nepenthes*. From the lowlands, I had stared up at its summit across rice paddies and water buffalo, and caught brief glimpses through openings in the clouds and mist in the early morning. I had thought that the summit areas appeared perfect for finding new *Nepenthes* – I had seen montane vegetation on the ridgetops that I could view, and these mountains lay disjunct from the rest of the Victoria Massif, and so logically could potentially harbor distinct *Nepenthes* populations that may be sufficiently isolated to have evolved as distinct species.

On arriving back in Palawan this time, and viewing the mountains once more, they looked more interesting than ever – particularly after a tricycle-driver whom I had hired promptly informed me that on “those mountains” (*i.e.* the Mount Victoria massif), there is a “flower that eats mice”. He had not seen the plant himself, but read about it in newspapers and on the television. No doubt, he was referring to *N. attenboroughii*, which had received media attention worldwide a few years earlier after Alastair, Volker, and I published our description of it as being one of the largest pitcher plants.

So, on November 16<sup>th</sup>, Greg, Mark, Jehson, and I set out to reach the northern ridgeside arm of this complex. We anticipated that trails would most likely penetrate the lowland rainforest close to the base of the mountain since hunters, animal-trappers, and resin collectors work widely throughout Palawan’s lowland forests, and most probably would be active here. We expected that the trails would end after we had gained one thousand meters or so in elevation since at this altitude, the vegetation becomes thinner and more montane which causes both the game and the resin trees to become increasingly scarce. We had planned that at this point of transition we would cut a trail to the upper slopes and summit of the northern ridge, and if possible, follow the ridgetop around the drainage of the central valley by proceeding westwards, then south and then finally east along the southern ridgetop to fully survey for *Nepenthes* flora before making our descent.

After purchasing supplies and finding six native guides and porters with home-made, wooden and rattan backpacks, we began our trek, first following the rivers and streams as far as we could, and then the faint trails that passed, as we had suspected, hunting traps and great *Agathis philippinensis* resin trees (known locally as almaciga). The animal traps seemed mostly set up for catching birds, although we did pass hunting parties with dogs, long spears, and guns that were searching for wild boar. I had seen similar hunting parties on earlier expeditions to Mount Victoria and Sultan’s Peak.



The resin trees all bore alarming cuts and gashes gouged into their sides. These machete-carved parallel grooves run deep into the bark and are made periodically every few months. Over time, resin drains from the trees and accumulates below the wounds, slowly solidifying from a sticky oozing, transparent fluid, into a white, translucent, brittle mass that feels waxy to the touch. Once harvested, the resin is sold in local markets and used for making lacquer and wood varnish internationally, and for starting fires locally. The solid resin is an essential tool which all of the local hunters carry, and ignites even when wet, and burns with an intense, powerful flame. The resin collectors mainly live in shacks in the unwelcoming frontier between of the untamed wilderness and the rice padis, and commonly travel for many days or weeks, often passing kilometers to reach specific trees which they have previously prepared. The collectors are bound by a form of honorable code, and each one harvests resin only from the trees which he has personally carved – it would be too easy to steal resin from friends, neighbors, or enemies, though without unique markings, the collectors memorize where their trees are, and which ones they have prepared and when.

The resin collector's livelihood also depends upon an understanding that the trees should only bear cuts on three sides, not fully around their circumference which kills the trees completely. Unfortunately, in recent years, as more and more collectors seek resin, the *Agathis* trees have become increasingly drained of resin, causing large numbers of the trees to die, causing the remaining trees to be harvested with increasing frequency and intensity, with the result that the trees are increasingly endangered and have been almost entirely wiped out from many parts of the Philippines. Happily, large populations still remain in the remoter forested areas of Palawan, although the life of the collectors is nevertheless physically extreme, and collectors reap little reward. On earlier trips, I learned that the market price for a kilogram of resin may be 20 Philippine pesos (US \$0.50, or GB £0.30), and most resin collectors may collect only a few kilograms of resin each day.

On November 18<sup>th</sup>, we reached the upper slopes of the northern ridge side of our goal, and the first open, lower montane forest that we had encountered. Around midday, we stepped into a small clearing and abruptly found an abandoned shelter made of cut hardwood sticks bound together with rattan cord, and roofed with weaved palm leaves. The construction rested against a great rock, and had been made by the seldom seen Ta-ot Batu tribe who usually make their homes in the great caves of Palawan – indeed even their name translates to “people of the stone”, but the Ta-ot Batu are very fearful of outsiders and shun modernity, still living a largely traditional hunting lifestyle. This was no doubt a hunting shelter, and it had been recently used – the palm-leaf roof of was still green, but I found green rattan cane inside and mounds of rice husks nearby. After a brief rest, we continued onwards, and left behind all sign of human presence.

As evening fell, we established camp high up on the exposed flanks of the ridgeside, close to the ridge summit itself. Our guides macheted a clearing among bamboo scrub and mossy trees and Greg, Mark, and I erected our tents, while the Filipino contingent of the expedition set up large tarpaulins and hammocks which they prefer. From this campsite, I could gain my first impressions of the vegetation of the ridgetop we were ascending. As far as I could discern, the ridgetop ahead appeared quite different from the other peaks that I had climbed in the Victoria Massif in previous years – it was laden with thick montane forest and I began to wonder whether our ridge would be too low-lying or too vegetated to harbor highland *Nepenthes* plants. As our party sat around a small wood fire in the fading light of dusk under a wet and dripping tarpaulin, Greg, Mark, and I discussed this possibility and hoped our efforts had not been in vain. But at that moment, just as we were in despair, I observed a familiar leaf with a tendril growing in heavy shade, in vegetation at the side of our campsite – a *Nepenthes* plant! It was a sickly specimen, surviving at the lowermost part of its altitudinal range. The plant was etiolated and devoid of traps

and flowers, and so it was impossible to establish if it represented a known species or otherwise – this discovery would have to wait.

After a night of intense rainfall and heavy dew, the following morning we all awoke early to continue our ascent to the summit of the ridge. Progress became excruciatingly difficult as the elevation leveled off and the vegetation became ever denser and eventually impenetrable. We could proceed only by following our guides and porters who macheted a narrow path in front. We encountered a few *Nepenthes* plants on the ridgetop, and found several plants in pitcher – their traps were reminiscent of *N. deaniana*, *N. gantungensis*, and *N. mira*, but they bore a peristome that was flatter and broader than those three species, and we observed several plants with dark red, purple, or even pure black pitchers – coloration not known in any of the Palawan *Nepenthes*. Although the traps were different in shape from *N. deaniana*, *N. gantungensis*, and *N. mira*, we determined to continue onwards with the goal of finding a higher point of altitude where a larger and healthier population of the *Nepenthes* plants to study. After a full day of cutting a trail, our GPS devices revealed that we had proceeded only a few hundred meters along the ridge top and so I climbed a tree to sight our path. As the clouds cleared in the distance, I caught view of a large, sharp-sided pyramidal peak looming above our ridge beyond a steep valley several hundred meters away. Separating us from the peak was an even, unbroken sea of dense vegetation along the ridgetop. We returned to the camp that we had established the previous evening, the macheted remains of the vegetation cutting into our legs as we scrambled down the narrow trail.

On arriving back at camp, we caught sight of the southerly arm of the complex through a clearing in the trees. We could see that our original goal of proceeding around the ridgetop to descend by way of the southern arm was impossible – it would have taken many weeks to machete around the full perimeter of the U formed by the ridgesides. To our frustration, we could see that the southerly ridge looked much more suitable for highland *Nepenthes* – it comprised of low growing, grassy scrub which is the known habitat of for giant *N. attenboroughii* and *N. palawanensis* type species which we had hoped to find. Neither *N. attenboroughii* nor *N. palawanensis* occur in montane forest such as that which we were laboriously cutting our trail through on the northern ridgeside. We had only five days of provisions remaining, and so jointly decided to set our goal on reaching the summit of the pyramidal peak that I had seen through the mist.

The next morning, we awoke again early and roused the guides to continue macheting the trail-head. The laborious work grew more and more difficult, but after five hours or so we had reached the valley separating the ridgeside and the pyramidal peak, and began descending. Along the valley sides, Greg, Mark, and I found the *Nepenthes* plants growing rooted to cliffsides, with their great pitchers hanging down the cliffs in midair. We continued onwards, and suddenly and abruptly, the trail cut through into an open clearing of a vast swamp. Our guides and porters were as amazed as we were, for they had never seen or heard of such a place occurring on any mountain nearby, and immediately explained that this clearly showed no person had reached this spot previously since otherwise this wetland would have been cultivated as it made a perfect natural rice padi. In the swamp, we found large wallows, presumably made by wild pigs, and amongst the grasses, we discovered a sparse population of “*Drosera* sp. A” – a newly discovered sundew that occurs across several islands in South East Asia. It is a sundew which I had encountered on Mount Victoria and Mount Mantalingahan on earlier expeditions that is closely related to *D. spathulata*, and occurs consistently on ultramafic substrate. The plant was previously known from seepage habitat on ultramafic rocks, but not in open, wet marsh such as we had found.

From the swampland, we had a clear view of the pyramidal peak that lay ahead of us. Our lead guide suggested that the mountain was Schom-carp Peak which was viewed and known from the





Figure 1: The lower pitchers of a *Nepenthes leonardoi* plant growing on the summit of Schom-carp Peak.

lowlands, but had never been ascended. After a short break, our party of guides continued macheting the trail ahead for the final assault, and three hours later, we finally reached the summit. Along the trail, the *Nepenthes* plants had become increasingly more common, and we found the species to be





Figure 2: The striking dark upper pitchers of a color variant of a *Nepenthes leonardoi* plant. Note this pitcher is not dead – see photo on Back Cover in which a flash was used.



Figure 3: The broad peristome of an upper pitcher of a *Nepenthes leonardoi* plant. Note the prominent peristome ribs.

most populous in patches of lower bushy scrub on the summit. We found the most vigorous plants growing in direct sunlight amongst the shortest vegetation. In such habitat, the plants produced stout climbing rosettes bearing oblong leaves that bore similarity to those of *N. deaniana*, *N. gantungensis*, and *N. mira*. However, unlike those species, we observed few plants growing inside the montane forest vegetation bearing vines longer than two meters long. And although very closely related to those species, a systematic comparison of the leaves, pitchers, stem, and inflorescences revealed stable differences from all three species (McPherson *et al.* 2011).

The *Nepenthes* produced stout lower pitchers up to 24 cm long, lined with a broad peristome bearing prominent peristome ribs that terminate into long, hard, sharp inward protruding spikes. Prominent wings ran down the front of the lower pitchers, and often the lid was elevated far above the pitcher opening on an elongated column of the peristome, lined with forward, enlarged protruding peristome spikes. The lid lacked an appendage, and the spur was narrow and up to 6 mm long. The latter characteristic confirmed our suspicions that the plant was more closely related to *N. deaniana*, *N. gantungensis*, and *N. mira* than *N. attenboroughii* and *N. palawanensis* since the latter plants have very distinctive, exceptionally broad spurs.

The upper pitchers were very variable in color, but consistent in shape and overall characteristics (see Figure 1). At one extreme, we found a minority of plants with small, infundibular, purplish black upper traps (see Figure 2 and Back Cover), while the majority of specimens produced upper pitchers that were pure yellowish green, or green with an orangish-red peristome. The upper pitchers bore a more bulbous and prominent peristome than *N. deaniana*, *N. gantungensis*, and *N. mira*, and similar peristome ribs and inward protruding spikes comparable to the lower traps (see Figure 3). Often, a prominent ridge (although not a fully-formed appendage) was discernable on the lower

surface of the lid, above the point of attachment with the peristome. The largest upper pitchers which I observed were 26 cm long, and unlike *N. deaniana*, *N. gantungensis*, and *N. mira*, upper pitchers were produced abundantly and in greater numbers on most plants than the lower traps. The inflorescences bore similarity to the *N. deaniana*, *N. gantungensis*, and *N. mira* group, but bore an exceptionally strong and distinctive odor (McPherson *et al.* 2011).

On the morning of our sixth day, we began our descent, passing rapidly back along the trail we had cut, and past the Ta-ot Batu shelter. Before nightfall, we had reached the lowlands, and managed to find a tricycle driver willing to take us to the nearest town for a much-needed night of relaxation, happy in the accomplishments of our expedition. When we reached the lowlands, we were sad to hear that day we had begun our climb, one of the great Filipino botanists and a personal friend, Leonardo Co, had been shot dead along with two other botanist colleagues in Luzon, in fighting between communist rebels and the government troops. Leonardo had worked intensively for more than three decades, documenting traditional uses of native plants of the Philippines. It seems a sad irony that this black-pitched plant was found as he had died. We decided together that we would name the plant *Nepenthes leonardoi*, to honor his lifetime's work to studying the Filipino plant life, including *Nepenthes*. Troublingly, I had traveled close to the forests where Leonardo had been shot during earlier expeditions.

The discovery of this plant reinforced thinking that the currently known *Nepenthes* species of Palawan fall into three natural groups. *N. deaniana*, *N. gantungensis*, *N. mantalingajanensis*, *N. mira*, and *N. leonardoi* all bear similar morphology and ecology, but are distinguished from one another by minor but consistent structural foliar or floral differences. Of this group, *N. mantalingajanensis* is the most distinct in that it produces much small and uniquely shaped leaves that are an adaptation to its exposed habitat on Mt. Mantalingahan, the tallest peak on Palawan. *Nepenthes attenboroughii* and *N. palawanensis* also form a very clear pair of closely related species, and are noteworthy for bearing some of the largest and most voluminous traps of all pitcher plants. Although very closely related, many clear morphological characteristics separate these two plants apart, not least that *N. attenboroughii* rapidly produces upper pitchers, whereas *N. palawanensis* produces only large, hairy, great lower traps even when fully mature and flowering. The third group comprises the only lowland species of Palawan, the endemic *N. philippinensis* which is more closely related to *N. alata* than any other palawean *Nepenthes* (McPherson 2009).

A great number of peaks on Palawan remain unexplored, not least the limestone outcrops scattered across the island which hold particular promise for possible endemic *Nepenthes* species. It certainly seems that we still have much to learn of the incredible and much underestimated diversity of the *Nepenthes* of the Philippines.

Photos and videos of this expedition and of *Nepenthes leonardoi* can be viewed at [www.redfernnaturalhistory.com](http://www.redfernnaturalhistory.com).

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## BOOK REVIEWS

by Bob Ziemer

**Carnivorous Plants and Their Habitats: Volume 1** (723 pages, 374 photographs) and **Volume 2** (719 pages, 425 photographs).

Stewart McPherson; Edited by Andreas Fleischmann and Alastair Robinson.

2010. Redfern Natural History Productions Ltd., Poole, GB. ISBN-13: 97809555891854

These books should be considered one 1442-page tome that is divided into two volumes containing 799 excellent photos and 740 references.

### **Volume 1** [number of pages in section]

Introduction [9]

Tables Turned: A New Natural Order [42]

Carnivorous Plants of the World [16]

Evolution of Carnivorous Plants (by Andreas Fleischmann) [56]

Associated Life: Mutualists and Infauna [20]

Habitats of Carnivorous Plants [38]

Snap Traps [6]: *Aldrovanda* [34]; *Dionaea* [46]; Pitcher Plants [34]; *Darlingtonia* [44], *Heliamphora* [56], *Sarracenia* [78], *Nepenthes* [138], *Cephalotus* [50], *Brocchinia* [34], *Catopsis* [34]

### **Volume 2**

Sticky-Leaved Insect-Eating Plants [24]: *Triphyophyllum* [30], *Drosera* [102], *Drosophyllum* [40], *Roridula* [34], *Byblis* [32], *Pinguicula* [74], *Ibicella* and *Proboscidea* [26], *Philcoxia* [16]; Cork-screw Plants *Genlisea* [38]; Bladderworts *Utricularia* [86]

The future of Carnivorous Plants and their Habitats [56]

Appendix: *N. gantungensis* [10], *N. hamiguitanensis* [10], *N. holdenii* [26], and *N. palawanensis* [8], The Elusive *Nepenthes thorelii* (François Mey) [28]

Glossary [6]

Bibliography: 740 references

Index [8]

**Carnivorous Plants and their Habitats** is an outstanding encyclopedic work that covers the ecology, diversity, and natural history of each carnivorous plant genus in great detail. Each genus chapter is a self-contained treatise with the headings: Distribution, Botanical History, Plant Structure, Habits and Ecology, Traditional Uses, Associated Life, Cultivation Requirements, Conservation Status. These volumes will be invaluable to botanists, naturalists, and horticulturalists, as well as anyone with an interest in carnivorous plants. I found the five introductory chapters of Volume 1 to be particularly interesting to read and Andreas Fleischmann's "Evolution of Carnivorous Plants" to be quite thought-provoking. Volume 2 includes the formal descriptions of four new *Nepenthes* species (*N. gantungensis*, *N. hamiguitanensis*, *N. holdenii*, and *N. palawanensis*). The chapter on *Philcoxia* introduces three rare species that are potentially carnivorous.

The Index has a number of errors, directing the reader to incorrect pages. These are only minor detractions from two excellent volumes.

### **Bizarre Botanicals: How to Grow String-of-Hearts, Jack-in-the-Pulpit, Panda Ginger, and Other Weird and Wonderful Plants**

Larry Mellichamp and Paula Gross, with Foreword by Tony Avent

284 pages, 114 color photos

2010. Timber Press, Portland, Oregon; London, UK. ISBN-13: 9781604690767

This book is written for the general public, particularly those that seek an introduction to a wide range of unusual plants. There are short 2- to 3-page plant profiles, including brief growing tips, for each of 75 strange plants. Chapter 1 is titled Carnivorous Plants (33 pages) and includes profiles on *Cephalotus*, *Darlingtonia*, *Dionaea*, *Drosera*, *Heliamphora*, *Nepenthes*, *Pinguicula*, and *Sarracenia*. Those with a passing knowledge about carnivorous plants will likely find nothing new. The remainder of the book contains profiles for 67 other non-carnivorous botanical curiosities.



## INTERNET HERBARIUM ADVENTURES

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Have you ever dreamed, like I have, about adventures in exotic lands studying carnivorous plants, and making great discoveries? Are you like me, and can't afford to undertake grand botanical expeditions? While it may not be field work, one inexpensive way of exploring the world of carnivorous plants is to journey into the land of online or internet-based herbariums.

Recently, many herbariums have been placing searchable databases of their collections online. The ICPS forum has a growing list of online herbaria that you can explore from the comfort of your home or office.

Experienced botanists and scientists are well-versed in the use of herbariums (in-person or online), however the botanical research novice may not always completely understand the intricacies of their use. Embarking on online herbarium adventures, I find there are two tips that are well worth following. First, always read the herbarium's online tips or frequently asked questions. Second, always work with herbaria staff to address any unresolved questions or to validate records accessed if you plan to use the information in research or publication.



Figure 1 Scan of the *R. dentata* specimen, Division of Paleobotany, YPM164317. Courtesy of the Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA.



Figure 2 Scan of the original *R. dentata* specimen label, Division of Paleobotany, YPM164317. Courtesy of the Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA.

Here's a good example of how following the tips helps you avoid any embarrassment. In my Web Wanderings, exploring online herbarium collections for *Roridula* records, I accessed the Yale University Peabody Museum Paleobotany online catalog (<http://www.peabody.yale.edu/collections>). I reviewed a record for *Roridula dentata* with great excitement! The online database listed the specimen as being collected in Australia in 1897. An apparent discovery: A record of a species endemic to one continent collected across an ocean on another continent! See Figure 1.

Following the advice of the herbarium website, I contacted the collections manager to validate my discovery. It was good that I did before announcing my great discovery. At my request the collections manager and the curator reviewed the specimen and documentation, and after some research they concluded that there was an error in the transcription of the original herbarium label (Shusheng Hu, collection manager, personal communication; see Figure 2).

Reviewing the original label they noted that what was thought to be the collectors name is actually a location in South Africa (Bokkeveld) with a potential altitude of 5000 feet. The "Australia" label was transcribed in error and probably was meant to be *Africa australis* (South Africa in Latin) where *R. dentata* is endemic. In further reviewing the label contents, I found that a Latin translation of *regio occidentalis* is "western region". Putting all of the pieces together the specimen was probably collected in an area in the western region (*regio occidentalis*) of South Africa (*Africa australis*) where *Roridula* has been found.

So, while I didn't actually have a major discovery, I was able to make a contribution to the field by helping to ensure the accuracy of the specimen record—something I feel good about.

You can start your carnivorous plant adventure today by visiting the ICPS forum to explore the growing list of online herbaria. Remember the herbarium tips and have a great journey!

Thank you to Shusheng Hu of the Division of Paleobotany, Peabody Museum of Natural History, Yale University for assistance with reviewing the specimen and herbarium database.

## DO WE HAVE ANY EVIDENCE THAT ANY PLANTS HAVE GIVEN UP CARNIVORY?

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Keywords: carnivory: evolution

This might have happened several times during the evolution of the carnivorous groups that we know today. We can even observe partial or total loss of carnivorous traits in some well-known carnivorous plant groups today: *Drosera caduca* for example produces non-carnivorous leaves when adult (consisting only of an elongated petiole, without a carnivorous lamina anymore), and bears carnivorous glandular leaves only in the juvenile stage and shortly after regrowing from dormancy. *Drosera schizandra*, a species of rainforest floors, bears only a very sparse cover of carnivorous glands, and the mucilage is easily washed away, and not continuously replaced as in most other *Drosera* species. This species could be considered on the way to becoming a “post-CP” in adaptation to its habitat.

Some of the rheophytic *Utricularia* species (most notably *U. neottioides* and *U. rigida*) produce traps only occasionally, and many specimens do not have a single trap anymore. Several other aquatic *Utricularia* species are known to reduce their number of traps (up to total loss) when growing in nutrient rich water.

If we consider the carnivorous *Drosophyllum* as the basal branch of the Caryophyllales-clade leading to the carnivorous genus *Nepenthes*, it seems likely that its sisters, Dioncophyllaceae, have almost fully lost carnivorous adaptations (sticky glandular leaves present only in a single genus, *Triphyophyllum*, and only during a short stage of its life; the remaining two genera of this family (i.e. *Dioncophyllum* and *Habropetalum*) are tropical lianas that apparently do not produce any carnivorous leaves anymore). The other sister family, Ancistrocladaceae, consists of entirely non-carnivorous plants, which might have lost their sticky foliage in adaptation to rainforest habitats.

The last example is less likely, but not impossible. If we consider Sarraceniaceae (CP) as the basal sister of the family sister pair Roridulaceae (CP) + Actinidiaceae (non-CP), it might be possible that the whole Chinese gooseberry family are descendants of carnivorous (or subcarnivorous?) ancestors. Of course carnivory is more likely to have evolved two times independently in the carnivorous Ericales (leading to two different trapping strategies, namely the pitfall traps in Sarraceniaceae and the flypaper traps with digestive mutualism in Roridulaceae), but we cannot exclude that the ancestors of this lineage perhaps had pre-carnivorous adaptations.

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## NAMES OF CULTIVARS REGISTERED IN 2010

- Byblis* 'David' B.Barnes. Carniv. Pl. Newslett. 39:43 (2010), registered on Jul. 28.  
*Dionaea* 'Alien' G.Bily. Carniv. Pl. Newslett. 39:119 (2010), reg. Dec. 29.  
*Dionaea* 'Coquillage' G.Bily. Carniv. Pl. Newslett. 39:118 (2010), reg. Dec. 29.  
*Dionaea* 'Korean Melody Shark' G.W.Jang & W.H.Yoon. Carniv. Pl. Newslett. 39:45 (2010), reg. Jul. 28.  
*Dionaea* 'Korrigans' G.Bily. Carniv. Pl. Newslett. 39:36 (2010), reg. Jul. 28.  
*Dionaea* 'Mirror' D.Blancquaert. Carniv. Pl. Newslett. 39:78 (2010), reg. Oct. 04.  
*Dionaea* 'Scarlet Bristle' R.Keehn. Carniv. Pl. Newslett. 39:37 (2010), reg. Jul. 28.  
*Pinguicula* 'Bettie' C.Weinberger. Carniv. Pl. Newslett. 39:81 (2010), reg. Oct. 04.  
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*Sarracenia* 'Eloise' T.Bailey. Pl. Carniv. 32(2):34 (2010), reg. Dec. 29.  
*Sarracenia* 'French Kiss' C.Azais. Carniv. Pl. Newslett. 39:38 (2010), reg. Jul. 28.  
*Sarracenia* 'Johnny Marr' M.Soper. Carniv. Pl. Newslett. 39:120 (2010), reg. Dec. 29.  
*Sarracenia* 'Mountain Splendor' J.Dallas. Carniv. Pl. Newslett. 39:79 (2010), reg. Oct. 04.  
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